A Work Project, presented as part of the requirements for the Award of a Masters Degree in Economics from the Faculdade de Economia da Universidade Nova de Lisboa.

QUANTITATIVE EASING

Rui Alexandre Rodrigues Veloso Faustino 444

A Project carried out on the Macroeconomics major, with the supervision of:

André Castro Silva

January 2012

Quantitative Easing

Abstract

Since November 2008, the Federal Reserve of the United States pursued a series of large-scale asset purchases, known as Quantitative Easing. In this Work Project, I describe the context, the objectives and the implementation of the Quantitative Easing. Additionally, I discuss its expected effects. Finally, I present empirical evidence of the effects on interest rates, output and inflation. I conclude that the first round of purchases was effective on preventing deflation and depression while the second had a small impact on economy.

Keywords: Quantitative Easing, zero lower bound, credit policy, balance sheet

I. Introduction

With interest rate policy tool constricted by the zero lower bound, the Federal Reserve used, since September 2008, its balance sheet as the main tool of monetary policy in the response to the financial crisis. Within the series of policies used to accommodate the negative effects of the financial crisis, the most preponderant was Quantitative Easing, a set of targeted asset purchases programs funded through deposits of reserves.

Here, I explain the implementation of Quantitative Easing and its objectives. On the second part, I discuss the expected effects of large-scale asset purchases with the model in Cúrdia and Woodford (2011). Finally, I discuss the empirical evidence on the effects of Quantitative Easing.

Although it is unconventional, Quantitative Easing is not a new policy tool. In essence, it represents an increase of bank reserves and, therefore, an increase in the supply of money through the open market operations. Nonetheless, the Federal Reserve's Quantitative Easing differs from the previous ones on the targets of the purchases (Bernanke (2009)). In November 2008, the Federal Open Market Committee (FOMC) announced the intention to purchase $500 billion of mortgage-backed securities (MBS) and $100 billion in debt of housing-related government enterprises (agency debt). The purchases, executed through open market operations, which comprehended assets that were not normally traded by the Federal Reserve, were large enough so that they would have/had a large impact on the mortgage related markets and on the credit markets in general.

During 2009, FOMC increased the targets of the purchases to $1.25 trillion of MBS, $200 billion in housing agency debt and initiated the purchase of $300 billion of

long-term Treasury securities. In November 2010, a second round of quantitative easing began with the intent of purchasing $600 of long-term Treasury securities, in response to slow pace economic recovery and deflationary pressures verified in the first quarters of 2010. Additionally, FOMC would keep reinvesting the principal payments agency debt and mortgage-backed securities in long-term Treasury securities.

The effects of purchases on interest rates, inflation and economic growth have been the subject of analysis of many research papers in recent years. While some authors such as Cochrane (2011), Cúrdia and Woodford (2011), Doh (2010) focused on modeling the possible effects of quantitative easing, other authors, including Chung et al. (2011), Gagnon et al. (2010), Krishnamurthy and Vissing-Jorgensen (2011) and Stroebel and Taylor (2009), studied the empirical evidence of the impact.

For the analysis of the expected effects on interest rates, aggregate demand and inflation, I use the New Keynesian model with credit frictions in Cúrdia and Woodford (2011). According to the model, when the zero lower bound is reached, the purchases of assets like MBS and agency debt have a positive effect on credit spreads and aggregate demand as opposed to Treasury purchases that have no effects.

In the last section, I discuss the empirical evidence about the effects of Quantitative Easing on macroeconomic variables. Moreover, I analyze the evolution of interest rates of mortgages and corporate bonds during 2008-2011 to discuss the effects of Quantitative Easing. To examine the impact of quantitative easing on inflation, I apply the spread between nominal Treasury securities and Treasury Inflation Protected Securities (TIPS). Using the spread between 10-year and 3-month Treasury securities, I discuss the effect on the economic activity.

I conclude that the first round of Quantitative Easing had significant effects on credit spreads and successfully avoided a scenario of deeper recession. On the other hand, the second round had relatively small effects, where most of them resulted from the signaling given to market participants about FOMC's desire to keep short-term interest rates low for a long time.

II. Quantitative Easing

Since the summer of 2007, the Federal Open Market Committee decided to accommodate the negative effects of subprime mortgage crisis by continuously lowering short-term interest rates. In less than a year, the committee reduced the federal funds target rate in 325 basis points, which, according to Bernanke (2009), seemed not to be sufficient to offset the negative impact on economy of credit restriction. In December 2008, FOMC fixed the target rate at 0-25 basis points. At this level, the federal funds rate reached the zero lower bound, since Federal Reserve is not allowed to pay negative interest rates on federal funds. (Data from Board of Governors of the Federal Reserve System.)

As the federal funds rate cannot decrease beyond the zero lower bound, the FOMC could no longer use an interest rate, given by the federal funds rate, as its main instrument of monetary policy. For this reason, the FOMC decided to use its balance sheet as an instrument of monetary policy. In order to reduce the interest rates and increase the lending in private credit markets, especially in the mortgage credit markets, the Federal Reserve launched a series of large-scale asset purchases known as Quantitative Easing.

Starting on November 2008, the purchases comprehended both debt and mortgage-backed securities issued by the government-sponsored enterprises Fannie Mae, Freddie Mac and Ginnie Mae. Because MBS are bonds representing an investment over a pool of real estate loans that are used as instrument to increase mortgage lending, their purchase along with the purchase of debt of housing agencies would provide a stimulus to credit and housing markets.

All the purchases were funded by deposits of reserves in financial institutions' accounts at Federal Reserve and executed through open market operations, conducted by the Federal Reserve Bank of New York (New York Fed). The assets purchased and sold are held in the System Open Market Account (SOMA) which serves as collateral for the liabilities on the Federal Reserve System's balance sheet. With the beginning of Quantitative Easing, the volume of holding assets and bank reserves on Fed's balance sheet expanded to considerable levels. By the end of March 2010, when the purchases of MBS and agency debt ended, the Federal Reserve had around $1.4 trillion more in assets and $1.1 trillion more in total reserves at its balance sheet. (Figures 1 and 2)

Traditionally, open market operations included almost exclusively Treasury securities and were designed to have minimal effects on the assets involved. In contrast, asset purchases programs under Quantitative Easing were designed to have a large impact on interest rates and prices of the assets acquired, as well as other assets with similar characteristics.

According to the Federal Reserve Bank of New York, because of the complexity of the assets involved and dimension of the program, the purchases of MBS required the expertise of external investment managers that had responsibility of provide advisory services and execute the purchases on behalf of Federal Reserve on a daily-basis.

These purchases of MBS were done in the secondary market and directly with Federal Reserve's primary dealers. To avoid buying overpriced securities, the Federal Reserve measured the changes in liquidity of each class of mortgage-backed securities and adjusted the pace of purchases to it. The liquidity was measured according to different criteria that included relative price valuations, trading volumes and indications of supply imbalances (Gagnon et al. (2010)).

By the end of its purchases, the Federal Reserve held two thirds of total outstanding MBS with 4 and 4.5 percent coupon rates, the most issued coupon classes while first round of Quantitative Easing took place (Sack (2009)). Because the newly-issued MBS result from the new mortgages, the purchases of MBS focused on these classes so the credit availability for new mortgage loans would increase.

Due to the smaller dimension of the program and the less complex nature of the assets involved, the agency debt purchases did not required external expertise and were conducted by New York Fed staff alone. To execute the transactions, the Federal Reserve organized multi-price reverse auctions on a weekly basis. Initially, the purchases of agency debt focused on less liquid securities, but to promote the market functioning and mitigate market dislocations, the scope expanded to more liquid securities such as the newly-issued. Because the purchases were proportional to the amount of agency debt available in the market, the securities with 2-5 years maturity that had larger outstanding supply, were the most purchased (Gagnon et al. (2010)).

On March 2009, the Committee decided to increase the volume of purchases of mortgage-backed securities to $1.25 trillion, to increase the purchases of agency debt to $200 trillion and to start the purchase of $300 billion of long-term Treasury securities. The Treasury securities purchase program had the duration of six months and the

purchases were conducted at rhythm of one to two per week. The transactions followed the same process as the agency debt, through multi-price auctions with primary dealers as counterparties. (Figure 3)

As the purchases successfully reduce interest rates on mortgages, the refinancing activity increased, leading to an acceleration of repayments of principals on MBS held in SOMA. As a result, the volume of long-term securities held by private investors increased and the long-term interest rates were higher. To stop the rise of long-term interest rates, FOMC decided, on August 2010, to maintain the size of SOMA holdings. To accomplish this, the revenue from the payments of principals on MBS held in SOMA was used in additional purchases of long-term Treasury securities.

On November 2010, concerned with economic outlook, the FOMC announced the second round of quantitative easing with the intent to foster the economic recovery and to ensure stable price levels consistent with the FOMC mandate. To accomplish this, the Committee directed the New York Fed to purchase $600 billion of long-term Treasury securities, in the following eight months at a pace of $75 billion per months. In addition, the New York Fed had instructions to keep the reinvestment of principal payments from SOMA holdings in the acquisition of long-term Treasury debt. By the end of program, June 30, 2011, the Open Market Trading desk had executed $767 billion of purchases. (Data from Federal Reserve Bank of New York.)

III. Expected effects of quantitative easing

Cúrdia and Woodford (2011) use a New Keynesian model with an extension to include credit frictions. The economy has three sectors: households, financial intermediaries and a central bank.

Financial intermediaries play a role in this model because of the heterogeneity in spending opportunities across households and the lack of expertise to borrow and lend funds among themselves. There are two types of households: the *borrowers*, more impatient to consume, borrow funds in equilibrium; the *savers*, more patient to consume, save in equilibrium. The marginal disutility from working differs so that the two types of households work the same hours in equilibrium. The difference between impatience to consume leads to the necessity of reallocation of funds between the two types, therefore, financial intermediation matters.

The intermediary sector is comprised of perfectly competitive firms. The intermediaries take deposits that are perfect substitutes of riskless government debt as investment for saving households and pay the same nominal return i_t^d one period later. Then, they can choose to make one-period loans L_t which demand the payment of i_t^b and the quantity of reserves M_t to hold at central bank that pay the nominal interest of i_t^m.

There are two types of borrowers: the good that will repay the loans one period later and; the bad that will not repay their loans. The intermediaries cannot distinguish between the two types, only can know the fraction of bad loans $\chi_t(L_t)$. Moreover, they incur at operational costs, therefore, they consume real resources $\Xi_t^p(L_t; m_t)$ in the period when loans are originated. The resources consumed increase with the size of

operations L_t and decrease with the real supply of reserves $m_t = M_t/P_t$. For any level of credit L , there is a satiation level $\overline{m}_t(L)$, the lowest value of m for which $\Xi^p_{mt}(L_t; m_t) = 0$.

To finance the costs of intermediation and the loans that are not repaid, financial intermediaries are forced to charge higher nominal interest rates on loans than they pay on deposits. The objective function of intermediaries is given by

(1) $$d_t - m_t - L_t - \chi_t(L_t) - \Xi^p_t(L_t; m_t)$$

The deposits that are not used to finance loans and reserve acquisition are considered earnings. They maximize their earnings by choosing L_t and m_t. The two first order conditions are

(2) $$\Xi^p_{Lt}(L_t; m_t) + \chi_{Lt}(L_t) = \omega_t \equiv \frac{i^b_t - i^d_t}{1 + i^d_t}$$

(3) $$-\Xi^p_{mt}(L_t; m_t) = \delta^m_t \equiv \frac{i^d_t - i^m_t}{1 + i^d_t}$$

In the first equation, the credit spread ω_t is always positive ($i^b_t > i^d_t$ for all t) and a function $\omega_t(L_t; m_t)$ of real supply of reserves and aggregate volume of private credit. On the second equation, the differential δ^m_t between interest rates on deposits and on reserves depends on the same two aggregate quantities.

Moreover, the market-clearing condition requires that supply of credit correspond to the demand of credit

(4) $$b_t = L_t + L^{cb}_t,$$

where the supply includes both lending from private intermediaries L_t and lending to private sector by central bank L^{cb}_t. Central bank can choose between lending L^{cb}_t and

holding government debt, both paying nominal interest of i_t^d, restrained by the real reserve supplying m_t.

(5) $$0 \leq L_t^{cb} \leq m_t.$$

When it lends to private sector, central bank has a cost function $\Xi^{cb}\left(L_t^{cb}\right)$ which is increasing and $\Xi^{cb\prime}(0) > 0$. In equilibrium, it charges the same nominal interest i_t^b of private intermediary loans, thus making i_t^m the only rate that it is able to choose.

However, the central bank is able to influence i_t^d in two different ways: if the central bank chooses to vary the reserve supply m_t, it forces the differential δ_t^m to change; and if chooses to vary i_t^m, i_t^d will be different for any given δ_t^m. Thus, central bank can control both i_t^m and i_t^d separately as long as $0 \leq i_t^m \leq i_t^d$, for any period t. This imposition comes from the resource cost function $\Xi^{cb}\left(L_t^{cb}\right)$ and the impossibility to pay negative interest rate on reserves.

So, in this model, the central bank has three different dimensions of policy: interest-rate policy, by choosing the target for i_t^d; reserve supply policy, when chooses the nominal amount of reserves M_t and; credit policy, by choosing the amount of lending to private sector L_t^{cb}.

Now we can define the aggregate variables of economy. First, the aggregate demand Y_t as

(6) $$Y_t = \sum_{\tau} \pi_\tau \, c^\tau(\lambda_t^\tau; \xi_t) + G_t + \Xi_t,$$

where $\pi_\tau c^\tau(\lambda_t^\tau; \xi_t)$ represents the weighted expenditure demands of function of household with type $\tau = \{b, s\}$, which depends on marginal utility of income λ and shocks on preferences, G_t the exogenous public spending and Ξ_t the amount of resources consumed by financial intermediaries (including Central Bank).

Inflation is determined by

$$\Pi_t = \Pi(Z_t), \tag{7}$$

$$where\ Z_t = z\left(Y_t, \lambda_t^b, \lambda_t^s, \xi_t\right) + \mathrm{E}_t[\Phi(Z_{t+1})]$$

Here, inflation is determined not only by the aggregate demand, marginal utility gap, $\Omega_t = \lambda_t^b / \lambda_t^s$, and the external shocks ξ_t, but also by expected future aggregate outputs and future marginal utility gaps.

The social welfare is given by

$$U_t = U(Y_t, \Omega_t, \Xi_t, \Delta_t;\ \xi_t), \tag{8}$$

where U_t is a function of aggregate demand Y_t, marginal-utility gap Ω_t, cost of financial intermediation Ξ_t, index of price dispersion Δ_t and, external shocks on preferences, technology and public spending. There is an interior maximum for welfare as function of aggregate demand due to its impact on marginal utilities of consumption and work. Welfare is monotonically decreasing with Ω_t, the measure of inefficiency on credit allocation, with Ξ_t, the resources consumed on financial intermediation and Δ_t, the measure of inefficiency in price dispersion of composite good.

How quantitative easing could be effective

According to this model, Quantitative Easing corresponds to an expansion of the reserve supply M_t. Then, the central bank can use the funds obtained to concede credit L^{cb} to the borrowing households, which would correspond to what Federal Reserve when it bought MBS and agency debt. Alternatively, the central bank can choose to buy riskless government debt, which is the case of second round of quantitative easing.

If we take (2), we can confirm that there is an optimal level of reserve supply for each L_t so the differential $\delta_t^m = \Xi_{mt}^p(L_t; m_t) = 0$. Thus, the optimal policy for reserve supply is the one that

$$\frac{M_t}{P_t} \geq \overline{m}_t(L) \tag{9}$$

Any increase in M_t until satiation level will produce a reduction of private intermediaries cost, therefore having an impact on welfare through, both the marginal-utility ratio Ω and aggregate intermediaries cost Ξ. Given that all demand for reserves is satisfy and $\delta_t^m = 0$, there is no benefit from any increase in bank reserves through the reduction of the intermediation costs Ξ^p.

However quantitative easing can improve welfare in two other ways: if it corresponds to a change the expected path of future policy rate i_t^d or if is used to finance lending to private sector L_t^{cb}. Due to the "New Keynesian Phillips curve" in (7), if Central Bank commits to keep policy rate i_t^d for a longer time, even after the economic recovery, today's expectation about future inflation will be higher and so, deflation can be prevented like output depression can be prevented. This result is similar to the ones present in Eggertsson and Woodford (2003) and Werning (2011).

In this model, the focus is on the case where central bank uses the increase in reserves to finance the lending to the private sector. This can be considered to be the case when the Federal Reserve purchased MBS and agency debt that could be viewed as an indirect way of Fed to lend to household and business due to the nature of these assets.

In order to explain how, in this model, an increase in lending by central bank through quantitative easing could contribute to stabilize the economy after the financial

crisis, we have to assess how effective it would be compared to an interest rate policy. Assuming that the Central Bank follows a interest rate policy specified by

$$i_t^d = max\{\bar{r}^d + \phi_\pi \pi_t + \phi_y \hat{Y}_t, 0\}, \tag{10}$$

where $\pi_t = \log \Pi_t$ is the inflation rate, $\hat{Y}_t = \log(Y_t/\bar{Y})$ and $\bar{r}^d$ is the steady-state real policy rate. And that the credit policy follows the rule

$$L_t^{cb} = -\gamma(L_t - \bar{L}), \tag{11}$$

where $\bar{L}$ is the level of lending from private intermediaries at steady-state, and $0 \leq \gamma \leq 1$ is the degree of response of central bank lending to shocks in private lending. If $\gamma = 0$, the central bank follows the policy of "Treasuries only", where it only uses reserves to finance purchases of riskless Treasury securities and cannot lend to private sector anytime. If $\gamma = 1$, the central bank will completely offset the variation in lending from private intermediaries so aggregate credit will be at steady state level $\bar{b} = \bar{L}$.

The higher the degree of response of central bank lending, the less damaging will be the effects of a financial disturbance that cause an increase in credit spread $\bar{\omega}_0(\bar{L})$. The more credit L^{cb} concedes, the less will fall the aggregate lending, the aggregate demand and the welfare. Moreover, the central bank will not have to reduce the policy rate so much.

In the case of no costs associated to central bank lending, the optimal degree of response would be $\gamma = 1$, but because central bank consumes resources when lends to the households, there is an optimal choice of L^{cb}. Considering $\Xi^{cb}(L^{cb})$ increases at least weakly convex and $\Xi^{cb\prime}(0) > 0$, so there is always a positive marginal cost from lending, the optimal choice of L^{cb} is given by

$$\varphi_{\Xi,t}\left[\bar{\Xi}_t^{p\prime}\left(b - L_t^{cb}\right) - \Xi^{cb\prime}\left(L_t^{cb}\right)\right] + \varphi_{\omega,t}\left[\bar{\Xi}_t^{p\prime\prime}\left(b - L_t^{cb}\right) + \chi_t''(b - L_t^{cb})\right] \leq 0, \tag{12}$$

$$L_t^{cb} \geq 0, for\ all\ t \tag{13}$$

where $\varphi_{\Xi,t}$ and $\varphi_{\omega,t}$ are shadow values and, the first term and second terms are the partial derivatives, with respect to L_t^{cb} and holding the value of total borrowing constant, of Ξ_t and ω_t, respectively.

If the cost of central bank is sufficiently large, "Treasuries only" will be the optimal policy in a steady state and in cases where disturbances cause small increases on credit spread. A optimal credit policy involving $L_t^{cb} > 0$ will occur in the case of large financial disturbances that increase the marginal cost of private intermediation $\bar{\Xi}^{p\prime}$. The most favorable case to an active credit policy is the one where the spread increases due to a shock in $\bar{\Xi}_t^{p\prime}$ and $\bar{\Xi}_t^{p\prime\prime}$. Figure 4 shows the comparison between the "Treasuries only" and the optimal credit policy, in that case. There, the optimal credit policy keeps the overall lending and aggregate demand constant while in its absence they fall sharply.

Considering that interest rate policy was restrained by the zero lower bound since December 2008, the credit policy conducted by FOMC through the purchases of MBS and agency would, according to this model, contribute to an improvement in welfare. Rather than being part of a simple reserve expansion, the purchases of private debt would consist in an increase of central bank lending that would offset the impact of the decrease in the aggregate private lending and, therefore, avoid a rise in credit spreads and a decrease in aggregate demand.

On the other hand, the purchase of Treasury securities would correspond to a "Treasuries only" policy. Although it might be considered the optimal credit policy since the financial disturbances that anticipated FOMC decisions on March 2009 and on November 2010 were smaller than when FOMC decided to initiate Quantitative Easing on November 2008, the result would be null. Since the beginning of 2009, the interest

rate paid on excess reserves was almost zero like the ones paid on federal funds and on 3-month Treasury bills, which would mean $i^t = i^m$ and, therefore, δ_t^m=0. Any expansion of reserves that would have no effects on credit spreads ω or aggregate lending b.

Under this model, the FOMC will still be able to meet its inflation targets in the future even after the expansion of bank reserves because the interest rates and the balance sheet belong to two independent dimensions of central bank's monetary policy, a large amount of excess reserves is consistent with high short-term interest rates.

IV. Empirical Evidence on the Effects of Quantitative Easing

A. Previous Studies

Here, I do a survey of empirical evidence on the effects of Quantitative Easing based on economic literature about the subject.

Gagnon et al. (2010) present an event study about the effects on interest rates. The results were fairly positive: not only the interest rates on Treasuries, agency debt and MBS declined notably but also the yields on Baa corporate bonds and swap rates fell, indicating widespread effects of purchases. Additionally, when comparing event to non-event days came to conclusion that the purchases contributed to relaxation of financial strains and to reverse the flight-to-quality flows.

Other authors, such as D'Amico and King (2010), Doh (2010) and Hamilton and Wu (2011), focused their research on the effects of the purchases of Treasury securities. Doh (2010) analyzed the impact of the March's 2009 announcement on 10-year

Treasury yields and concluded, like Gagnon et al. (2010), that the purchases of Treasuries contributed to the reduction of the term premium on 10-year Treasury bonds. Hamilton and Wu (2011) found statistically significant forecasting relations between the structure of Treasury debt held by the public and argued that a policy of large-scale Treasury purchases had the potential to reduce the overall interest rates level of an economy at zero lower bound. D'Amico and King (2010) found that the purchases had a greater effect on similar and less liquid assets and that even anticipated, they had significant effects.

More recently, Krishnamurthy and Vissing-Jorgensen (2011) used an event study of communications similar to Gagnon et al. (2010) and regression to discuss the effects of both rounds through different channels on yields of different assets and inflation expectations.

According to it, the first round of quantitative easing reduced the inflation uncertainty and avoided deflation by increasing 10-year expected inflation up to 146 basis points. More notably, the increase in Treasury supply during 2009 had large impact on safety premium when the demand for safety was around 2.5 times the demand prior to the crisis and a smaller impact during the second round as the demand decrease to normal levels. This is consistent to the mechanism in Cochrane (2011) where the supply of public debt was no longer effective when the demand for safe assets was stable. One of the most relevant findings is that the efficacy of the second round of quantitative easing depended largely on the signaling channel and, specifically, on the announcement of Fed's intention to keep the fed funds rate close to zero until mid-2013, which makes the success of second round to depend more on the communication than the purchases themselves.

B. Observed Effects

Here, I discuss the impact of Quantitative Easing on interest rates, inflation expectations and economic growth. To do that, I use data from the Board of Governors of the Federal Reserve System. First, I focus on the evolution of the interest rates of mortgages and corporate bonds (Figure 5) and on the evolution of the yields of Treasury securities of different maturities (Figure 6). Then, I analyze the effects of large-scale asset purchases on inflation expectations (Figure 7) and on economic activity (Figure 8).

Figure 5 shows the evolution of interest rates on corporate bonds and mortgages. By the end of the second round of quantitative easing, the interest rate on Baa corporate bond was around 350 bps lower than in November 2008. The largest reduction, 320 bps, took place during the first round of quantitative easing. In this period, the interest rates on Aaa bonds had a smaller reduction, about 140 bps which contributed to a decrease in the spread between the two interest rates. This result suggests that quantitative easing, but mostly the first round, contributed to a reduction in reduction of spreads and interest rates in the private credit market.

The effects on interest rate of 30-year mortgages are less pronounced, which is consistent with finds in Stroebel and Taylor (2009). Nonetheless, the refinancing activity that followed the purchases of MBS is one of the causes behind a less successful decline in the interest rates of mortgages.

In the same period, the Treasury yields had a different response to quantitative easing. As a response to the announcement of the purchases of MBS and agency debt, in November 2008, the yield on 10-year Treasury securities fell sharply compared to the yield on 2-year Treasuries, which indicates a decrease in term premium like Gagnon et

al. (2010) suggest. As the purchases started to be executed, the yields on 5-year and 10-year Treasuries started to rise. This is consistent with the results in Cochrane (2011), where the purchases of private debt would counterbalance the flight to quality flows and would reduce the interest rates on private debt and raise the interest rates on public debt. (Figure 6)

In order to forecast the changes in inflation expectations, the spread between the nominal treasury notes and treasury inflation protected securities (TIPS) can be used as a proxy. However, there are two factors influencing this measure: the inflation risk, which makes investors in TIPS overstate expected inflation and; the liquidity risk, linked to the illiquidity in TIPS market which makes it to understate expected inflation. (see Carlstrom and Fuerst (2004)).

The graph in Figure 7 shows that quantitative easing helped to stabilize inflation expectations around the FOMC mandate for inflation of 2%. First, the 5-year and 10-year inflation expectations that had been falling since July 2008, started to rise right after the announcement in November 2008. Although the inflation expectations fell, like the inflation rate, during the two first quarters of 2010, it was around 2% during 2011.

In order to discuss the impact of large-scale purchases on economic growth, I use the spread between 10-year and 3-month Treasury securities yields which can be used to forecast future economic activity (see Haubrich (2006)). Both in the last quarter of 2008 and in the two three quarters of 2010, the spread registered a reduction of 140 bps. This was an indicator of deceleration of economic activity in the periods that anticipated the announcements of the two rounds of quantitative easing. Both rounds,

but mostly the first, had a significant impact on the spread which might indicate a positive impact on economic growth. (Figure 8)

V. Conclusion

I discuss the implementation and the effects of the Quantitative Easing conducted by the Federal Reserve System of United States between November 2008 and June 2011. The first round had strong positive effects on interest rates, mainly on the spread between the interest rates on Baa and Aaa corporate bonds and on the spread between the 10-year and 2-year Treasury yields which made possible the stabilization of the inflation expectations around the Federal Reserve mandate of 2% and the improvement of economic activity. In its turn, the second round had less pronounced effects on those variables as a result of both the kind of securities involved and the more stable credit markets.

REFERENCES

Bernanke, Ben S. 2009. "The Crisis and the Policy Response." Stamp Lecture, London School of Economics, January 13. http://www.federalreserve.gov/newsevents/speech/bernanke20090113a.htm.

Carlstrom, Charles T., and Timothy S. Fuerst. 2004. "Expected Inflation and TIPS." Federal Reserve Bank of Cleveland, *Economic Commentary*, November.

Chung, Hess, Jean-Philippe Laforte, David Reifschneider, and John C. Williams. 2011. "Have We Underestimated the Likelihood and Severity of Zero Lower Bound Events?" Federal Reserve Bank of San Francisco Working Paper 2011-01

Cochrane, John H. 2011. "Understanding Policy in the Great Recession: Some Unpleasant Fiscal Arithmetic*." European Economic Review* 55(1): 2-30

Cúrdia, Vasco, and Michael Woodford. 2011. "The Central Bank Balance Sheet as an Instrument of Monetary Policy." *Journal of Monetary Economics*, 58(1): 54-79

D'Amico, Stefania, and Thomas King. 2010. "Flow and Stock Effects of Large-Scale Treasury Purchases." Finance and Economics Discussion Series Paper No. 2010-52, Board of Governors of the Federal Reserve System

Doh, Taeyoung. 2010. "The Efficacy of Large-Scale Asset Purchases at the Zero Lower Bound." Federal Reserve Bank of Kansas City *Economic Review* Q2: 5-34

Eggertsson, Gauti B., and Michael Woodford. 2003. "The Zero Lower Bound on Interest Rates and Optimal Monetary Policy." National Bureau of Economic Research Working Paper 9968

Federal Reserve Statistics and Economic Data. 2011. Board of Governors of the Federal Reserve System. http://www.federalreserve.gov/econresdata/releases/statisticsdata.htm (accessed 11 December, 2011)

FRED Economic Data. 2011. Federal Reserve Bank of St. Louis. http://research.stlouisfed.org/fred2/ (accessed December 11, 2011)

Gagnon, Joseph, Matthew Raskin, Julie Remache, and Brian Sack. 2010. "Large-Scale Asset Purchases by the Federal Reserve: Did They Work?" Federal Reserve Bank of New York Staff Report 441

Hamilton, James, and Cynthia Wu. 2011. "The Effectiveness of Alternative Monetary Policy Tools in a Zero Lower Bound Environment." National Bureau of Economic Research Working Paper 16956

Haubrich, Joseph. 2006. "Does the Yield Curve Signal Recession?" Federal Reserve Bank of Cleveland *Newsletter,* April 15.

New York Fed. 2011. Federal Reserve Bank of New York. http://www.newyorkfed.org/index.html (accessed December 11, 2011)

Sack, Brian. 2009. "The Fed's Expanded Balance Sheet." Remarks at the Money Marketeers at NYU, December 2. http://www.newyorkfed.org/newsevents/speeches/2009/sac091202.html

Stroebel, Johannes C., and John B. Taylor. 2009. "Estimated Impact of the Fed's Mortgage-Backed Securities Purchase Program." National Bureau of Economic Research Working Paper 15626

Werning, Ivan. 2011. "Managing a Liquidity Trap: Monetary and Fiscal Policy." National Bureau of Economic Research Working Paper 17344